CHAPTER TWO: SOME STUDIES ON VOWEL QUALITY

2.1 SOME EARLY STUDIES OF VOWEL QUALITY:

One of the earliest attempts to apply spectrographic analysis to vowels was an unpublished study by Skelton (1950). Skelton did a spectrographic analysis of Spanish vowel sounds. He recorded twenty (20) male subjects representing the Spanish of various parts of South Western United States, Latin America and Spain and did comparative studies on the vowels in primary, secondary and unstressed positions in isolated words. He then plotted the vowels in the various phonetic contexts on formant charts with F1 on the abscissa and F2 on the ordinate and found out that differences exist between comparable vowel sounds of the different dialects of Spanish.

The most frequently cited of the pioneering studies on vowel quality was undertaken by Peterson, G. and Barney, H. L. (1952). Using the vowels of American English, the researchers introduced some controls in the study of vowel quality. First, all the vowels were recorded in the "same" consonant environment of /h-d/. Additionally, a large number of speakers (as opposed to just a handful) were recorded for analysis. The speakers included males, females, children and adults. The result of these two controls is that their research findings had real statistical significance. The formant vowel chart resulting from this study has, for a long time, served as the benchmark in acoustic studies – especially in vowel quality.

The acoustical correlates of the distinctive features of Russian were investigated by Morris Halle (1959). Halle obtained data by means of electrical measurements, the most important sources of data being visible sonagrams, and power spectra. He observed that in all the phonemes, the first formants of vowels contain a very large fraction of the total energy. For all but the first formants, the higher the formant frequency, the greater is its attenuation (i.e. the intensity of the formants reduce at higher frequencies). In the vowels however, the attenuation of the upper formants is less than in other phonemes. The vowels often have greater intensity than other phonemes and this distinguishes the vowels from other phonemes having formant structures.

Fant (1960) presents a very detailed, technical and comprehensive study of the speech sounds of Russian. It includes X-ray tracings of both consonant and vowels of the language. More importantly, the study attempts to correlate these X-ray tracings with spectrographic data as well as reconstructed spectra extracted from connected speech. Among other things, Fant notes that any vowel positioned close to a nasal consonant acquires some amount of nasalization. He also notes that "a small degree of nasalization is probably a normal attribute of very open vowels."

Wells J. C (1962) conducted a spectrographic study on the pure vowels of British English as embedded in /h-d/ monosyllabic words. He noted that, "Vowels are found to be characterized by peaks of energy around the frequencies corresponding to the natural frequencies of the supraglottal cavities as they during the articulation of the sound concerned and these frequency bands are the formants." He noted further that different

vowels are characterized by different formant frequencies and by peaks of energy at different frequencies. He explains that to the different shapes of the vocal tract and the different positions of the tongue there are corresponding frequency responses and passbands, giving rise to vowel sounds with different formants. “In order to be able to specify the vowel sounds of a language in acoustic terms, it is necessary to state, among other things, the frequencies of at least some of the formants characteristic of those vowels.”

Delattre (1964) conducted a pilot study entitled *Comparing the Phonetic Features of English, French, German, and Spanish.* He characterized the vocalic features of the individual languages and then compared them with each other, in an attempt to define what makes each language unique. A major finding of this study was that traditional labels such as high vs. low and front vs. back do, in fact, have both acoustic and auditory correlates.

Ladefoged (1964) combines a number of instruments and methods to study the speech sounds of a large number of West African languages. The languages studied included the following from Ghana: Akan (Fante and Twi), Anum, Ewe, Effutu, Ga, Kyerepong, Lateh, Logba, Nkonya, and Nzima. X-ray pictures were taken and tracings were provided for both consonants and vowels; palatographic measures were provided for consonants; photographs of lip positions were taken; spectrographic measures were provided for both vowels and consonants; a pitch meter was used for accurate description of tones; and transducers were used to record air pressure in the mouth, pharynx as well as subglottally. With the help of a tape repeater, Ladefoged performed elaborate auditory analysis of all the speech sounds of the languages investigated. No other phonetic study has been that thorough or has covered as many languages. Even so, the study does not say much about the actual vowel qualities of the languages under study. In fact, as far as vowels are concerned, the emphasis seems to be on vowel harmony i.e., which vowels can occur together in a polysyllabic word of a given language. Taking a critical look at the vowel harmony languages of West Africa, Ladefoged noted that the label tense/lax could only be used as a term of convenience, and “should not be interpreted as having a precise physiological meaning.”

Basing her work on earlier research, Dolphyne (1988) presented the Akan language (Twi and Fante) as having ten vowel sounds as shown in Figure 4. This is in partial agreement with Ladefoged (1964) who presents a ten vowel system for Twi but a nine vowel system for Fante. Dolphyne presented five nasalized vowels for Akan as /ĩ, ẽ, ã, õ, ũ/. This is quite interesting because the positioning of /e̙/ and /o̙/ make them correspond to the IPA symbols /ɪ/ and /ʊ/. If indeed both pairs /i, ɪ/ and /u, ʊ/ are nasalized, it will make the Akan phenomenon quite unusual. What is usually found in a language with five nasalized vowels is the set: /ĩ, ɛ̃, ã, ɔ̃, ũ/.

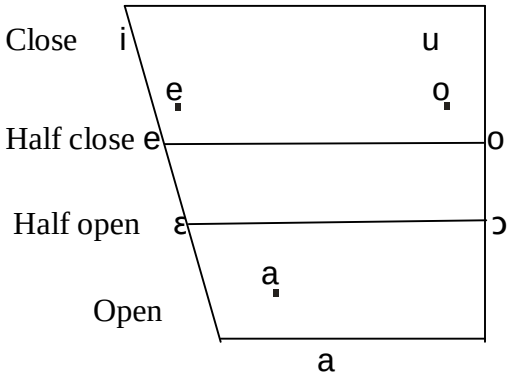

Figure 1.4: Akan Vowel Chart (as presented by Dolphyne 1988).

2.2 MODERN TRENDS IN VOWEL QUALITY RESEARCH:

Lindau (1977) used X-ray data from a number of African languages to suggest a set of features required for the description of vowel systems in natural languages. (The X-ray tracings were mostly taken from Lindau's 1975 UCLA Ph.D. thesis.) A strong point of this study is that Lindau explores the articulatory, acoustic as well as auditory correlates of each feature. She suggests, for instance, that a very important feature needed for the description of vowels in Akan could be "Expanded", which should correlate with the size of the pharynx. The suggested values for this feature are "expanded/neutral/constricted".

Lindau and Wood (1977) investigated the acoustic vowel spaces of three seven-vowel system languages from Nigeria and two nine-vowel system languages, one of which happens to be Akan, a close neighbour of GaDangme. The Akan data was taken from four speakers repeating each vowel five times. Formant values were obtained from the first three formant frequencies and compared. A major finding of this study is that in "Akan /e/ has practically merged with /ɪ/ . . . F3 for both vowels is around 2760Hz." Lindau and Wood offer the explanation that since the two vowels belong to different harmony sets in Akan, it did not "really matter that they are almost identical acoustically." In fact, in terms of vowel height, the two vowels seem to have reversed their positions in the acoustic space.

Godinez (1978) sought to determine on a scientific basis, the underlying phonetic parameters that characterize the vowels of the Romance languages. He analyzed Mexican, Argentine and Peninsular dialects of Spanish as well as Brazilian Portuguese. He recorded six speakers representing the speech of Tijuana, Mexico; four speakers representing the speech of Argentina Spanish of Buenos Aires; six speakers representing the speech of Peninsular Spanish representative of various geographical locations of

Spain; The Brazilian Portuguese data was recorded from four speakers of Sao Paolo, two speakers from Rio de Janeiro, two speakers from Espirito Santo, and a speaker from Bahia. After conducting spectrographic analysis on the recorded data he measured the formant frequency values for F1, F2, and F3 and plotted the values on a formant chart with F1 at the abscissa and F2-F1 at the ordinate. He realized that significant differences potentially exist in the qualities of vowels represented with similar symbols. He observed that the target areas of the vowels [u], [o], and [a] of Peninsular Spanish are positioned more closely than in the other two dialects of Spanish which seem to exhibit larger acoustic differences in the spacing of these back vowels. He also found some differentiation in the height of the front vowels in Mexican and Argentine Spanish dialects. The sound represented as [e] in Argentine Spanish seems to occupy a higher position than the comparative vowel of the Mexican Spanish dialect. The same type of relationship seems to hold true for [i] in Argentine and Peninsular Spanish. *In as much as the relationship between Spanish and Portuguese is similar to that between Ga and Dangme, this study is of much interest to the present study.*

Eric Zee (1978), investigated the effect of tone on vowel quality. He explored how formant frequencies change when a vowel is produced with different tones in natural speech produced by speakers of tone languages. He analyzed five Taiwanese Chinese vowels [i], [e], [a], [ɔ] and [u]. The vowels were uttered in two contrasting tones: high and low. Formant frequencies of the vowels were obtained from LPC spectra and fundamental frequencies from the corresponding spectrum. He observed that the vowels [i], [e], [ɔ], and [u] associated with high tone occupy areas in the acoustic space that are distinct from those occupied by vowels associated with low tones. He observed that the way the formant frequency pattern associated with the high tone differs from the formant frequency pattern associated with the low tone is unique for all three speakers recorded. Thus, he concluded that vowels are in fact affected by tonal differences although not in a systematic way for different vowels and for different speakers.

Disner (1978) investigated the features used by linguists to describe vowel quality. She evaluated the various statistical procedures employed in vowel normalization. In particular, she compared the vowels of six Germanic languages, namely, Danish, Dutch, English, German, Norwegian and Swedish. Her work is mostly based on acoustic data from other studies. For instance, she used formant frequency (F1, F2, F3) data of at least six male speakers per language from published accounts. A major finding of this study is that there are real differences between corresponding vowels in different languages. In other words, vowels represented by “same” symbols may be quite different as far as vowel quality goes.

Formant frequencies of Dutch vowels in tracheoesophageal speech were investigated by Corina J. and co. (1997), to find out the vowel formant characteristics of laryngectomized tracheoesophageal speakers of Dutch in order to find out the differences between tracheoesophageal vowels and the normal vowels. They observed that the second formants showed a significant difference for all the vowels. They found F2 for /u/ to be

significantly lower than the normal frequency and the F2 for /a/, and /i/ were significantly higher than the normal frequency.

Scott Shank and Ian Wilson (*2001*), carried out an acoustical analysis of vowel formants in pharyngeal and glottal contexts in Nuu-chah-nulth (Nootka), a Wakashan language spoken on the west coast of Vancouver Island. Their goal was to document and describe precisely the acoustic effects the glottal stop [ʔ] and the pharyngeal stop [ʕ] have on neighboring vowels in Nuu-chah-nulth with the assumption that such effects are a primary cue to their differentiation. They concluded that the pharyngeal causes a greater rise in F1 and a more substancial drop in F3 than the glottal stop. He saw that F1 and F3 are clear and consistent cues to pharyngealization.

Dominic Watt and Jennifer Tillotson (2001), conducted a spectrographic analysis of vowel fronting in Bradford English in order to match acoustic cues to the auditory impression of /o/ fronting. They investigated the acoustic characteristics of 337 tokens of /o/. They focused on one variable: the vowel found in words of the GOAT set such as: go, load, boat, snow, coal, and throat. The experiment yielded high frequency values for the second formants of the vowel for the speakers. This created higher differences between F1 and F2. They observed from the formant frequency values plotted that there are some indications in the acoustic signal of the fronting of the target of GOAT vowel in Bradford English. The fronting, which involves a shift away from the periphery of the vowel space towards a more central region is more advanced among the youngest speakers and the female speakers.

Mohammad Al-Masri and Allard Jongman (2004) researched the acoustic correlates of emphasis in Jordanian Arabic. They sought to find the characteristics of vowels and consonants in the vicinity of pharyngeal consonants. They measured the second formant frequencies as well as the vowel and consonant duration. They found out that lowering of F2 in vowels adjacent to the emphatic consonant (i.e. the pharyngeal consonant) is a clear and consistent acoustic correlate of emphasis. They noted that Emphasis spread beyond the target syllable in both leftward and rightward directions. Vowels [i] and [u] however, block the effect of emphasis on subsequent syllables.

The next two chapters present a spectrographic study of the vowel sounds of GaDangme.